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To: Mr. Bill Michaud
The Marasco Newton Group Ltd
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Subject: Preliminary Review Comments:
Modeling Framework Design (MFD)
Modeling Study of PCB Contamination in the Housatonic River

In beginning any review of models and modeling it's essential to understand just what a model is and is not as an adjunct to the definition of model purpose. When dealing with contaminants such as PCB's a model is generally considered to be a mathematical representation of our understanding of the processes governing the transport, fate and on some occasions effects of this pollutant. As such, accurate modeling requires care in both site assessment and numerical formulation. A model is not some artful simulation of reality and/or a means to avoid or replace detailed understanding of site specific processes. Every modeling exercise requires compromise and approximation but each of these is to be constrained by site characteristics and ultimately the desired/required accuracy and application of model results. It is against this background that I begin my review of the proposed EPA Modeling Framework Design (MFD) for the Housatonic River .

Purpose: The purpose of the proposed model is to provide a means to quantitatively evaluate the full range of physical, chemical, and biological factors affecting the transport, fate, bioaccumulation, and effects of PCBs within defined regions of the Housatonic River. The influence of both long-term, average ambient, and aperiodic, energetic storm events must be considered/accommodated. The model must be accurate and stable over long simulation times and complement evaluations of a variety of remediation scenarios, as required. The MFD outlines the approach proposed to achieve this goal.

Method : The proposed framework will use a watershed model (HSPF) to establish boundary loading conditions for a hydrodynamic/sediment/PCB model (EFDC) and a PCB fate and bioaccumulation model (AQUATOX). The resulting linked model will be initially applied to a specified river reach, defined as the Primary Study Area (PSA), extending from the confluence of the east and west branches of the Housatonic River to Woods Pond, a distance of approximately 11 river miles. The model is to be calibrated and verified using a variety of historical data and data obtained specifically as part of this effort. A quality assurance plan (QAPP) is presented as a means to establish the accuracy and reliability of the model results.

Preliminary Review Comments: The MFD presents a reasonably comprehensive listing of the primary factors governing the transport and fate of PCBs introduced into the Housatonic River. It lacks only some mention of atmospheric transport. This is understandable given the emphasis on the Pittsfield GE facility as the dominant source. Since this is likely orders of magnitude larger than any atmospheric inputs from distant source areas it may be acceptable to ignore for the moment. In the long term, however, the influence of persistent, low level, contamination may require consideration. Of more fundamental import, however, is the matter of

source definition and control.

The MFD provides only minimal discussion of the character of the existing PCB source(s) affecting the study area. This is essential information not only in terms of the quantities and chemical characteristics of the PCBs entering the area but their form (solute, DNAPL, etc.). Such data are required to evaluate fundamental transport characteristics such as retention times and/or trap efficiency of the variety of PCB reservoirs and the factors governing contaminant migration including sediment- water and contaminant-sediment exchange. Reviews suggest that data sufficient to specify these characteristics exist, or will on the completion of ongoing surveys. Careful consideration and discussion of implications is required as part of model formulation.

With the definition of source and specification of the extent to which continuing inputs of PCBs are controlled the next subject requiring increased care is the physical transport. This is a complex subject with a variety of interrelated components. All indications are that the dispersion of PCBs from the Pittsfield source is dominated by regional hydrology and the local sedimentary regime. Flows of both surface and ground waters are to be modeled using HSPF. This model appears to be well tested and in combination with the abundance of available longterm data describing meteorology, structural geology, topography, soils, vegetative cover and associated streamflows should yield reasonably accurate specifications of flow, sediment, and pollutant flux. Initial reviews leave only two questions unresolved. The first concerns the actual specification of PCB flux at the boundary and the second the subject of antecedent conditions . With regard to PCB flux it appears that this will be a defined value established independently of HSPF. Antecedent conditions are well recognized factors affecting regional hydrological transport and as such are undoubtedly included at some point within the model although the MFD makes only passing mention of them. This will be verified as part of the final review.

Following specification of flow, sediment and contaminant conditions at the upstream limit of the study area, subsequent transport is to be evaluated using the hydrodynamics and sediment transport model EFDC. Structuring and formulation of this model must follow an in-depth assessment of site characteristics. Although there is some indication that the data required to at least begin this assessment are available the MFD provides only limited, and a largely inferential, discussion of site characteristics. The rather perfunctory discussion of site characteristics and associated transport implications stands in sharp contrast to the in-depth detailing of model characteristics. I am uncomfortable with this and must question priorities. As indicated above, representative numerical modeling must be based on an understanding of site specific characteristics.

Preliminary review provides numerous examples of deficiencies in site characterization in the MFD. Taking as a given flows crossing the upstream boundary of the EFDC domain contaminant transport will vary as a function of streamflows and channel and sediment characteristics. A variety of data show that the resultant processes have produced significant concentrations of PCBs within the floodplain (10yr), side channels and oxbows, riverbanks, river channel and bars and terraces (Table 3-8). Average concentrations display a clear spatial pattern

with values progressively decreasing from the confluence to Roaring Brook and then increasing again on approach to Woods Pond (Fig. 3-15). It seems clear that the modeling of the processes governing these distributions represents a challenge. Fundamental to meeting the challenge is interpretation of the meaning of the observed PCB distributions. The MFD apparently proceeds on the belief/assumption that sequestering of PCB contaminated sediments due to burial by cleaner materials is limited (p.3-60-line 9-10). If this is so each of the observed distributions is part of an active deposit with at least the potential to serve as a source for future downstream transport. The basis for this assumption is however, less than clear. The first bit of information that would be useful is some indication of the mass of PCBs introduced by the GE facility relative to the mass retained at present in the system. This subject was discussed but briefly in a response to one of the initial Peer Review Committee questions. The answer suggested that there were orders of magnitude differences between what was introduced and what is currently resident. Such comparisons would complement evaluations of retention efficiency.

The next item of interest is detailed profile data of PCB concentration over the vertical sediment column. Detailing in the upper 6" is of particular interest. It seems possible that various degrees of isolation may be developing in at least some selected components of the system (bars, banks, floodplains etc.) that would be obscured by the composite sampling procedures used. The absence of any storage in the system in combination with significant PCB concentration would seemingly suggest that source has not been controlled. How is this accommodated in the model ?

Sediment detailing should not be limited to the vertical. In this meandering river its likely that erosion, transport and deposition results in spatially variant patterns of contaminant distribution in all components of the system. This view is supported by the less than homogeneous radionuclide patterns referenced at several points in the MFD. Some measure of this spatial variability is essential as justification for selection of particular concentrations as being “representative” and the definition of expected errors associated with model output and prediction. It’s also essential to justify selection of 2-D vs. 3-D modeling. I was surprised to see in the response to questions submitted by the Peer Review Committee that the model team planned to use the 2-D version of EFDC without any apparent justification. This deficiency must be corrected.

Following spatial detailing the MFD must make clear just how the processes affecting contaminant transport to and from each component of the system are to be handled. Of particular concern is the floodplain area. Is this to be treated simply as a contaminant sink ? What’s the role of vegetation ? A similar set of questions could be developed for the bars and terraces. Floodplains, bars and terraces, and channel banks are not easily accommodated in most sediment transport models. Why is the situation different for EFDC ? Given the contaminant concentrations observed in each of these areas, this is an important issue. It is not adequately addressed by the MFD.

Focusing on the nearshore and overbank areas does not mean that modeling sediment/PCB transport in the main channel is a simple matter. In contrast to these other areas, however, the formulation presented in the MFD is reasonably complete and the proposed

approach has the potential to yield useful results. Model development would clearly benefit from more detailed discussion of sediment spatial variability and its relationship to critical erosion velocities. For example, one might ask does the bed of the main channel represent a significant source of suspended materials during average ambient flows ? ..during storm events ? One interpretation of Figure 3-5 showing TSS peaking before stage height might be that channel erosion is secondary in importance to watershed supply. Such a conclusion if generally applicable would have profound implications for model development.

On the assumption that channel specific sediment transport plays a significant role, accurate modeling requires care in the specification of erosion, transport and deposition. In recognition of the site specific nature of the variables governing these processes some effort should be made to evaluate transport characteristics in the field. Time series observations upstream and down of a cohesive sediment deposit would provide data essential to the modeling. As a complement to these data field measurements of boundary shear stresses under a range of flow conditions should be obtained as part of the proposed ADCP surveys. This combination of data would provide a valuable check on the critical stress values developed using the SEDFLUME and assist in the calibration and verification of the hydrodynamic model. The MFD makes no mention of the need to provide such independent checks on boundary shear stress although it recognizes the need to generate stress values as input to the sediment transport module.

Moving from site characteristics to model formulation, the MFD provides no discussion of the proposed spatial schematization and only limited discussion of time steps and averaging. As noted above, I was surprised to see that a 2-D formulation was being seriously considered if not selected. I had assumed that the absence of detailed structural information for the model was due to delays associated with ongoing field surveys. i.e. the model developers were waiting to review field survey data before specifying grid dimensions and time steps. If this is not the case a clear presentation of all of these characteristics with justification should be developed for inclusion in the MFD.

In summary, this preliminary review indicates that the conceptual framework presented in the MFD includes the majority of processes/factors governing PCB transport in the selected reach of the upper Housatonic River (i.e. the PSA). The models proposed appear able to adequately simulate these processes if properly constructed, calibrated and verified. The insights necessary to model construction rely on careful and detailed site assessment. This assessment is poorly represented in the MFD. Similarly the associated data needs are poorly presented. The resulting deficiencies leave entirely too many parameters to be user specified and place into question the utility of the modeling exercise. Until this question is resolved evaluations of the extent to which the proposed model(s) will satisfy the objectives of the modeling approach as specified in the charge to the Peer Review Committee cannot be completed with confidence.